

# **Greenhouse Gas Emission Trends and Projections for Missouri, 1990 – 2015**

## **Technical Report**

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# Preface





## Preface

Several previous studies and reports serve as the background for this report on state greenhouse gas (GHG) trends and projections. In 1989, by concurrent resolution, the Missouri legislature established the Commission on Global Climate Change and Ozone Depletion. The Commission compiled information on sources of greenhouse gas (GHG) emissions in the state, analyzed possible local scenarios of climate change and identified adverse consequences for the state should climate change occur.<sup>1</sup>

The Missouri Commission listed adaptation measures as well as policy options to "reduce our contribution to global climate change." The Commission advocated an approach that emphasizes policies with benefits *in addition to* their impact on greenhouse gas emissions. The Commission stated that:

*...each option in this report [is proposed] because good environmental stewardship and energy efficiency will make Missouri stronger economically, improve our flexibility in the face of uncertain international energy markets, and fulfill our environmental responsibilities. These benefits prevail regardless of whether Missouri experiences substantial or subtle climate changes.*<sup>2</sup>

A similar approach to climate change policy was advocated in a study by a Missouri Department of Natural Resources Institute sponsored by the Missouri Department of Natural Resources in 1992.<sup>3</sup> The Institute's study recommended focusing on "no-regrets" policies that had concomitant economic and environmental benefits.

In 1996, the Division of Energy, Department of Natural Resources published an *Inventory of Missouri's Estimated Greenhouse Gas Emissions in 1990*. The report, funded in part through a grant from the U.S. Environmental Protection Agency (USEPA), provided a more detailed analysis of emissions sources than that published by the Missouri Commission.

This technical report on trends and projections was funded in part by a second grant from USEPA to the Division of Energy. The estimates and projections in this study provide a baseline estimate for the purpose of monitoring changes in the state's greenhouse gas and guiding the formulation of policies to reduce the state's greenhouse gas emissions. The Division of Energy will also produce a second report under the grant. The second report will identify state policies and action options to reduce greenhouse gas emissions in Missouri and will analyze the economic and environmental benefits and costs of these options.

Chapter 1 updates previous estimates of Missouri's 1990 baseline GHG emissions. The report focuses on four greenhouse gases in Missouri - carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and perfluorocabons (PFCs). Anthropogenic emissions of these four gases equaled approximately 148 Million Tons Carbon Dioxide Equivalent (MTCDE)<sup>4</sup> in 1990. About 75 percent of these emissions (111 million tons) were CO<sub>2</sub> emissions from fossil fuel use.

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<sup>1</sup> Missouri Commission on Global Climate Change and Ozone Depletion, *Report*, 1991. Jefferson City, Missouri.

<sup>2</sup> Missouri Commission on Global Climate Change and Ozone Depletion, *Report*, 1991. Jefferson City, Missouri, p. 66.

<sup>3</sup> DNR Institute 1991-92, *The Effects of Global Climate Change*, 1992. Jefferson City, Missouri, p. 22.

<sup>4</sup> The concept of carbon dioxide equivalent units is explained in Chapter 1.

Chapter 1 also provides an overview of the report's estimates of state GHG trends (1990 to 1996) and projections (1996 to 2015). The report estimates that between 1990 and 1996, gross emissions of the four greenhouse gases from all sources increased by about 20 million tons, from about 148 million tons (MTCDE) to 168 million tons (MTCDE).

Trends in CO<sub>2</sub> emissions from fossil fuel combustion are analyzed in Chapter 2, and trends in GHG emissions from other sources are analyzed in Chapter 5. Chapter 2 finds that CO<sub>2</sub> emissions from fossil fuel combustion increased by about 22 million tons between 1990 and 1996. In 1996, about 80% of gross GHG emissions (133 million tons) were CO<sub>2</sub> emissions from fossil fuel use. Chapter 5 finds that methane emissions increased by nearly 2 million tons MTCDE between 1990 and 1996, but this increase in methane emissions was more than offset by a decrease in PFC emissions of nearly 4 million tons MTCDE.

Rather than provide a single estimate for future GHG emissions, the report provides a range of estimates based on different projection methods and scenarios. All projections assume "business as usual," that is, no new policies to limit or reduce GHG emissions.

Chapter 3 projects future CO<sub>2</sub> emissions from fossil fuel combustion by utilities and Chapter 4 projects CO<sub>2</sub> emissions from fossil fuel combustion in other sectors. The resulting projections for gross CO<sub>2</sub> emissions from energy use in 2015 range from 154 to 170 million tons, with several projections falling into a midrange estimate of 161-163 million tons MTCDE.

Chapter 5 estimates GHG emissions from a variety of sources other than energy use. The chapter estimates that GHG emissions from some sources will decrease and others will increase between 1996 and 2015, but the total will be about the same in 2015 as in 1996, 34 to 35 million tons MTCDE.

The estimates in Chapters 2 through 5 all deal with gross GHG emissions from energy use and other sources. Chapter 6 provides estimates of net GHG emissions. The estimate of net emissions takes into account the effect of biomass growth in Missouri's forests, which cover nearly a third of the state, as well as land use changes. As explained in Chapter 6, the net effect of these factors in 1990 was to sequester about 20 million tons of carbon dioxide. Chapter 6 projects that annual carbon sequestration will decline over time, but discusses possible errors in the estimate due to limitations in the way that available models for estimating net sequestration deal with increased removal of forest products.

The analysis was completed by staff of the Division of Energy, Missouri Department of Natural Resources. Trend estimates were calculated in accordance with methodology specified in the *State Workbook: Methodologies for Estimating Greenhouse Gas Emissions*, published by the State and Local Outreach Program of USEPA's Climate Change Division. USEPA and the Energy Information Administration (EIA) of the U.S. Department of Energy have taken a lead role in developing methodology and sponsoring research on U.S. emissions and have published national emissions inventories. Staff in both agencies provided invaluable technical assistance to this project.

The State and Local Outreach Program has provided funding for greenhouse gas inventories by a number of states, including Missouri. Because these state inventories are based on 1990 data and use *State Workbook* methodology, it is possible to compare their results.

The estimation procedures used in the Missouri inventory, other state inventories and national inventories published by USEPA and EIA are based on an international research effort. The international effort has involved numerous U.S. researchers and has evolved during the past decade under the auspices of the Intergovernmental Panel on Climate Change (IPCC).<sup>5</sup> U.S. researchers have also been involved in this effort through U.S. national commitments under the Framework Convention on Climate Change.<sup>6</sup>

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<sup>5</sup> In 1988, the Intergovernmental Panel on Climate Change (IPCC) was jointly established by the United Nations Environment Program and the World Meteorological Organization in order to assess scientific information related to climate change issues. Under IPCC auspices, technical experts from over 50 countries and the Organization for Economic Cooperation and Development developed methods for estimating emissions and uptake of greenhouse gases, culminating publication of the *IPCC Guidelines for National Greenhouse Gas Inventories: Vol. 1-3* (IPCC, 1994).

<sup>6</sup> The U.S. was a signatory of the Framework Convention on Climate Change, which came into force on March 21, 1994. The Framework Convention commits signatories to develop national inventories of anthropogenic emissions of greenhouse gases. Accordingly, the U.S. government published the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1993* (USEPA 1994) and the *U.S. Climate Action Report* (U.S. Government, 1994).



# Acknowledgments



## Acknowledgments

This study was funded in part by a grant from the State and Local Outreach Program of the Climate Change Division of the U.S. Environmental Protection Agency (USEPA) and will be followed by a second report that will analyze the economic and environmental benefits and costs of state policies and action options to reduce emissions.

Anita Randolph, Director of the Division of Energy, made this project possible through her support and guidance. James Muench, Gerald Hirsch, Lesley Cryderman and Trish Whittle of the Division of Energy worked many long hours refining the concept, style and layout of the report.

The estimates and analysis in this study could not have been accomplished without the help of staff from a number of other state and federal agencies, who provided data and assistance in analyzing specific emissions sources. However, responsibility for the accuracy of the results rests with the Division of Energy.

Assistance was received from numerous Missouri state agencies, including:

- Missouri Department of Natural Resources, Division of Geology and Land Survey;
- Missouri Department of Natural Resources, Division of Environmental Quality, Air Pollution Control Program and Solid Waste Management Program;
- Missouri Highway and Transportation Department, Division of Planning;
- Missouri Department of Agriculture, Missouri Agricultural Statistics Service;
- Missouri Department of Conservation, Forestry Service;
- Missouri Department of Economic Development, Economic Development Programs and Public Service Commission;
- Missouri Department of Revenue, Division of Motor Vehicles and Tax Administration Bureau;
- University of Missouri-Columbia: Agricultural Extension Service, Fertilizer Control Service, Agricultural Experiment Station, School of Natural Resources, Food and Agriculture Policy Research Institute, Office of Social and Economic and Data Analysis (OSED), and School of Business and Public Administration Research Center;
- Missouri State Demographer; and
- Missouri State Library.

Assistance was also received from numerous federal and non-government sources. Federal agencies that provided data and methodological assistance include USEPA; U.S. Department of Agriculture, National Forest Service, North Central Forest Experiment Station; and U.S. Department of Energy (USDOE) Energy Information Administration (EIA). EIA staff were generous in providing unpublished data and providing critiques of methodology and data quality. ICF, a private firm contracted by USEPA to write the *State Manual* and to offer assistance to states pursuing inventory studies, was also consulted and provided data for the estimates. Other non-government sources providing assistance include Springfield Municipal Utilities and Noranda Aluminum, Inc.

